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Search History

DATE: Thursday, August 24, 2006 **Purge Queries** Printable Copy Create Case

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L3	("20040193337"| "US20040193337A")[ABPN1,NRPN,PN]	2	L3
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L1	20040193337	2	L1

END OF SEARCH HISTORY

L5: Entry 1 of 1 File: PGPB Sep 30, 2004

DOCUMENT-IDENTIFIER: US 20040193337 A1
TITLE: Control system and method

Abstract Paragraph:
A control system of the invention for regulating a quantity to be controlled based on a deviation of the controlled quantity from a target value thereof and control parameters includes a behavior feature value calculator, a basic state judgment data calculator and a control parameter setter. The behavior feature value calculator detects the period or frequency of behaviors of a specific kind performed by a subject to be controlled. The basic state judgment data calculator calculates the amount of variations in the aforementioned period or frequency. The control parameter setter updates the value of at least one of the control parameters based on the amount of the aforementioned variations.

Pre-Grant Publication (PGPub) Document Number:
20040193337

Summary of Invention Paragraph:
[0002] A situation occasionally experienced in feedback control operation is oscillation of a controlled system, or subject, in which a deviation of a quantity to be controlled from a target value thereof cyclically increases and decreases in a regular pattern. It is desirable to instantly detect such an oscillating state and vary appropriate control parameters in a manner suitable for the situation.

Summary of Invention Paragraph:
[0003] When the controlled subject is subjected to cyclically occurring external disturbances, the deviation of the controlled quantity from the target value oscillates (repetitively increases and decreases) in a regular pattern. In the presence of such oscillation, it is difficult to distinguish between the oscillation caused by the disturbances and ordinary oscillation caused by the feedback control operation. In a process of controlling the heading of a ship, for example, it is difficult to distinguish between an oscillating state caused by feedback control operation and an oscillating state caused by the influence of such external disturbances as cyclical rises and falls of ocean waves. Although it might be possible to distinguish between two kinds of oscillation based on whether the amplitude of periodic changes in the controlled quantity exceeds a preset threshold or not, the value of the threshold to be preset greatly varies with the type and nature of the controlled subject and seriousness of disturbances, so that this threshold approach imposes a great deal of difficulty in designing a control system.

Summary of Invention Paragraph:
[0006] A control system of the invention for regulating a quantity to be controlled based on a deviation of the controlled quantity from a target value thereof and control parameters includes a behavior feature value detector, a variation calculator and a control parameter updator. The behavior feature value detector detects the period or frequency of behaviors of a specific kind performed by a subject to be controlled. The variation calculator calculates the amount of

variations in the aforementioned period or frequency. The control parameter updator updates the value of at least one of the control parameters based on the amount of the aforementioned variations.

Summary of Invention Paragraph:
[0007] A control method of the invention for regulating a quantity to be controlled based on a deviation of the controlled quantity from a target value thereof and control parameters includes a behavior feature value detecting step, a variation calculating step and a control parameter updating step. The behavior feature value detecting step detects the period or frequency of behaviors of a specific kind performed by a subject to be controlled. The variation calculating step calculates the amount of variations in the aforementioned period or frequency. The control parameter updating step updates the value of at least one of the control parameters based on the amount of the aforementioned variations.

Summary of Invention Paragraph:
[0008] Generally, variations in a controlled quantity caused by cyclically occurring external disturbances are less "periodic" as compared to variations in the controlled quantity caused by oscillation thereof. According to the invention, the control system and the method used therein detect the period or frequency of behaviors of the controlled subject and vary the control parameters based on the amount of variations in the period or frequency of the behaviors, so that it is possible to properly control the subject even when the same is subjected to the influence of cyclically occurring external disturbances or oscillation of the controlled quantity.

Summary of Invention Paragraph:
[0009] In one feature of the invention, the control parameter updator decreases the value of a proportional control coefficient which constitutes one of the control parameters according to the amplitude of the controlled quantity when the amount of the aforementioned variations is smaller than a specific threshold value. This makes it possible to improve oscillating conditions caused by oscillation of the controlled quantity.

Summary of Invention Paragraph:
[0010] In another feature of the invention, the control parameter updator increases the value of a proportional control coefficient which constitutes one of the control parameters according to the magnitude of the deviation when the amount of the aforementioned variations is equal to or larger than a specific threshold value. In this form of the control system and method, the value of the proportional control coefficient may be increased only when the amount of the aforementioned variations is equal to or larger than the specific threshold value and the aforementioned deviation is equal to or larger than a specific value. Alternatively, the value of the proportional control coefficient may be increased by an amount corresponding to the magnitude of the aforementioned deviation. These alternative approaches make it possible to reduce the influence of external disturbances.

Summary of Invention Paragraph:
[0011] In another feature of the invention, the control parameter updator decreases the value of a differential control coefficient which constitutes one of the control parameters when the amount of the aforementioned variations is equal to or larger than the specific threshold value. This makes it possible to swiftly reduce the influence of external disturbances.

Summary of Invention Paragraph:
[0012] In another feature of the invention, the variation calculator calculates the amount of the aforementioned variations based on a standard deviation of the periods or frequencies of a specific number of the latest behaviors. This makes it possible to properly reflect a current control state in controlling the subject.

Summary of Invention Paragraph:
[0015] A control state judgment device used in a control system of the invention for regulating a quantity to be controlled based on a deviation of the controlled quantity from a target value thereof and control parameters includes a behavior feature value detector, a variation calculator and a control state judgment section. The behavior feature value detector detects the period or frequency of behaviors of a specific kind performed by a subject to be controlled. The variation calculator calculates the amount of variations in the aforementioned period or frequency. The control state judgment section updates a control state of the controlled subject based on the amount of the aforementioned variations.

Summary of Invention Paragraph:
[0016] A control state judgment method used in a control system of the invention for regulating a quantity to be controlled based on a deviation of the controlled quantity from a target value thereof and control parameters includes a behavior feature value detecting step, a behavior feature value detecting step and a control state judgment step. The behavior feature value detecting step of detecting the period or frequency of behaviors of a specific kind performed by a subject to be controlled. The variation calculating step of calculating the amount of variations in the aforementioned period or frequency. The control state judgment step of determining a control state of the controlled subject based on the amount of the aforementioned variations.

Summary of Invention Paragraph:
[0017] As already mentioned, variations in a controlled quantity caused by cyclically occurring external disturbances are less "periodic" as compared to variations in the controlled quantity caused by oscillation thereof. According to the invention, the control state judgment device and the method used therein detect the period or frequency of behaviors of the controlled subject and judges the control state of the controlled subject based on the amount of variations in the aforementioned period or frequency, so that it is possible to properly judge the control state by distinguishing between the variations in the controlled quantity caused by cyclically occurring external disturbances and the variations in the controlled quantity caused by oscillation thereof.

Brief Description of Drawings Paragraph:
[0023] FIG. 5 is a diagram showing how a deviation of a ship's true heading from an intended course varies with time;

Brief Description of Drawings Paragraph:
[0024] FIG. 6 is a diagram showing how the deviation and a first-order differential thereof vary during one ship behavior;

Detail Description Paragraph:
[0034] The steering unit 16 is conventional onboard equipment including a rudder driver for driving a rudder of the ship by means of a hydraulic pump and a cylinder, for example, and a rudder controller for matching a true rudder angle with a demanded rudder angle. The rudder angle sensor 15 connected to the steering unit 16 outputs a current rudder angle, that is, the true rudder angle .delta.r, which is fed into the adder 24 and the deadband processor 26. As the demanded rudder angle (.delta.r+.delta.D) is entered from the deadband processor 26 into the steering unit 16, the steering unit 16 varies the true rudder angle .delta.r so that the true rudder angle .delta.r matches the demanded rudder angle (.delta.r+.delta.D).

Detail Description Paragraph:
[0042] As an example, the behavior detector 52 sequentially calculates, based on values of the deviation (.theta.-.theta..sub.0) that are sequentially input, a difference between a latest deviation (.theta.-.theta..sub.0) and an immediately

preceding deviation (.theta.-.theta..sub.0), and judges that a point in time at which this difference varies from a positive value to a negative value is a timing at which the ship's heading .theta., which is the controlled quantity, takes a maximal value. At the same time, the behavior detector 52 judges that this point in time is an end timing of a preceding behavior of the ship and is also a start timing of a succeeding behavior of the ship. More particularly, the deviation (.theta.-.theta..sub.0) output from the adder 18 repetitively increases and decreases under ordinary situations as shown in FIG. 5. The behavior detector 52 detects every point in time at which the deviation (.theta.-.theta..sub.0) takes a maximal value, or at which the ship's heading .theta.takes a maximal value, in a yawing pattern of the ship shown by a waveform in FIG. 5 and supplies information on such a point in time to the behavior feature value calculator 56 as an end timing of a particular behavior of the ship and as a start timing of a succeeding behavior of the ship. In an alternative form of the embodiment, the behavior detector 52 may determine the start timing and the end timing of each behavior of the ship based on a point in time at which the ship's heading .theta. takes a minimal value or at which the plus and minus signs of a second-order differential are reversed.

Detail Description Paragraph:
[0058] Subsequently, the control parameter setter 62 determines the control parameters (KP, KI, KD) based on the aforementioned judgment result obtained by the control state judgment section 63. Specifically, the control parameter setter 62 infers that the ship (controlled subject) is in a meandering (oscillating) condition (first maneuvering state) if the oscillation index is judged to be large. In this condition, the control parameter setter 62 decreases the value of the proportional coefficient KP, among the aforementioned control parameters (KP, KI, KD). If necessary, the control parameter setter 62 may vary the values of the other control parameters (KI, KD). The amount of decrease of the proportional coefficient KP may be a fixed amount or determined each time according to the seriousness of oscillation based on the average value S_AVE of the behavior areas S, for example.

Detail Description Paragraph:
[0059] Also, if the disturbance index is judged to be large in a case where the ship is not in the first maneuvering state, the control parameter setter 62 infers that the ship is in a stormy condition (second maneuvering state). In this condition, the control parameter setter 62 increases the value of the proportional coefficient KP and decreases the differential control coefficient KD, among the aforementioned control parameters (KP, KI, KD). If necessary, the control parameter setter 62 may vary the value of the other control parameter (KI). The amount of increase of the proportional coefficient KP and the amount of decrease of the differential control coefficient KD may be fixed amounts or determined each time according to the seriousness of the stormy condition, such as the magnitude of the deviation (e.g., the maximum value S_MAX of the behavior areas S).

Detail Description Paragraph:
[0060] Further, if the gain shortage index is judged to be large in a case where the ship is in neither the first maneuvering state nor the second maneuvering state, the control parameter setter 62 infers that the ship is in a deviating condition (third maneuvering state). In this condition, the control parameter setter 62 increases the value of the proportional coefficient KP, among the aforementioned control parameters (KP, KI, KD). If necessary, the control parameter setter 62 may vary the value of the other control parameters (KI, KD). The amount of increase of the proportional coefficient KP may be a fixed amount or determined each time according to the seriousness of gain shortage based on the root mean square DV_CONT_RMS of the angular deviations of the center of the ship's behavior, for example.

Detail Description Paragraph:
[0066] According to the automatic steering control system 10 of the embodiment so

far discussed, it is possible to maneuver the ship in a stable fashion when the deviation of the ship's current heading .theta. (controlled quantity) from the intended course .theta.0 (target value) repetitively increases and decreases. This is achieved by judging the current control state (maneuvering situation) of the ship based on a regularity (pattern) of repetitive increases and decreases (variations) in the deviation and properly setting the control parameters based on the judgment result.

Detail Description Paragraph:
[0067] The invention being thus described, it will be obvious that the invention is not limited to the foregoing embodiment but may be varied in many ways. For example, the regularity (pattern) of periodical increases and decreases (variations) in the controlled quantity need not necessarily be evaluated based on the behavior period and standard deviation but may be evaluated based on the frequency of variations in the controlled quantity. While the foregoing discussion has illustrated one preferred embodiment in which the invention is applied to judging the current control state of the ship and controlling the steering unit thereof, the same is applicable also to other mobile units, as well as other types of controlled systems. Furthermore, the invention is applicable to controlling not only the direction of motion of a mobile unit but also the attitude or moving speed thereof. Moreover, the invention is applicable to controlling not only the motion of the mobile unit but also a physical quantity, such as temperature or density.

CLAIMS:

1. A control system for regulating a quantity to be controlled based on a deviation of the controlled quantity from a target value thereof and control parameters, said control system comprising: a behavior feature value detector for detecting one of the period and the frequency of behaviors of a specific kind performed by a subject to be controlled; a variation calculator for calculating the amount of variations in said one of the period and the frequency; and a control parameter updator for updating the value of at least one of the control parameters based on the amount of said variations.

2. The control system according to claim 1, wherein the control parameter updator decreases the value of a proportional control coefficient which constitutes one of the control parameters according to the amplitude of the controlled quantity when the amount of said variations is smaller than a specific threshold value.

3. The control system according to claim 1 or 2, wherein the control parameter updator increases the value of a proportional control coefficient which constitutes one of the control parameters according to the magnitude of the deviation when the amount of said variations is equal to or larger than a specific threshold value.

4. The control system according to claim 3, wherein the control parameter updator decreases the value of a differential control coefficient which constitutes one of the control parameters when the amount of said variations is equal to or larger than the specific threshold value.

5. The control system according to one of claims 1 to 4, wherein the variation calculator calculates the amount of said variations based on a standard deviation of one of the periods and the frequencies of a specific number of the latest behaviors.

9. A control method for regulating a quantity to be controlled based on a deviation of the controlled quantity from a target value thereof and control parameters, said control method comprising: a behavior feature value detecting step of detecting one of the period and the frequency of behaviors of a specific kind performed by a subject to be controlled; a variation calculating step of calculating the amount of variations in said one of the period and the frequency; and a control parameter

updating step of updating the value of at least one of the control parameters based on the amount of said variations.

10. A control state judgment device used in a control system for regulating a quantity to be controlled based on a deviation of the controlled quantity from a target value thereof and control parameters, said control state judgment device comprising: a behavior feature value detector for detecting one of the period and the frequency of behaviors of a specific kind performed by a subject to be controlled; a variation calculator for calculating the amount of variations in said one of the period and the frequency; and a control state judgment section for determining a control state of the controlled subject based on the amount of said variations.

11. A control state judgment method used in a control system for regulating a quantity to be controlled based on a deviation of the controlled quantity from a target value thereof and control parameters, said control state judgment method comprising: a behavior feature value detecting step of detecting one of the period and the frequency of behaviors of a specific kind performed by a subject to be controlled; a variation calculating step of calculating the amount of variations in said one of the period and the frequency; and a control state judgment step of determining a control state of the controlled subject based on the amount of said variations.

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L1: Entry 2 of 2 File: DWPI Jul 27, 2005

DERWENT-ACC-NO: 2004-708797
DERWENT-WEEK: 200549

TITLE: Automatic steering control system for use on ship, has control parameter updator to update value of control parameters based on variations in period and frequency of behaviors of ship detected by behavior feature value detector

INVENTOR: MAENO, H; MORITA, H ; UCHINO, E ; YOSHIOKA, T ; YAMAKAWA, T

PATENT-ASSIGNEE: FURUNO ELECTRIC CO LTD (FURE), ZH FAJISYSTEM KENKYUSHO (FAJIN), MAENO H (MAENI), MORITA H (MORII), UCHINO E (UCHII), YAMAKAWA T (YAMAI)

PRIORITY-DATA: 2003JP-0097320 (March 31, 2003)

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PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
JP 3677274 B2	July 27, 2005		014	G05B013/02
US 20040193337 A1	September 30, 2004		018	G06F017/00
GB 2400191 A	October 6, 2004		000	G05B011/01
JP 2004303086 A	October 28, 2004		014	G05B013/02

APPLICATION-DATA:

PUB-NO	APPL-DATE	APPL-NO	DESCRIPTOR
JP 3677274B2	March 31, 2003	2003JP-0097320	
JP 3677274B2		JP2004303086	Previous Publ.
US20040193337A1	March 26, 2004	2004US-0809340	
GB 2400191A	March 24, 2004	2004GB-0006643	
JP2004303086A	March 31, 2003	2003JP-0097320	

INT-CL (IPC): B63H 25/04; G05B 11/01; G05B 13/02; G05D 1/02; G06F 17/00

ABSTRACTED-PUB-NO: US20040193337A
BASIC-ABSTRACT:

NOVELTY - The system has a behavior feature value detector (52) for detecting a period and frequency of behaviors of a specific kind performed by a ship. A behavior feature value calculator (56) calculates the amount of variations in the period and the frequency. A control parameter setter (62) updates the value of the control parameters based on the amount of the variations in the period and the frequency.

DETAILED DESCRIPTION - INDEPENDENT CLAIMS are also included for the following:

(A) a control method of regulating a quantity to be controlled based on a deviation of the quantity from a target value and control parameters

(B) a control state judgment device used in a control system for regulating a quantity to be controlled based on a deviation of the quantity from a target value and control parameters

(C) a control state judgment method used in a control system.

USE - Used to control a ship in detecting oscillating state feedback control..

ADVANTAGE - The system judges the control state of the subject based on the amount of variations in the period or frequency, thus properly judging the state by distinguishing between the variations in the controlled quantity caused by cyclically occurring external disturbances and by oscillations.

DESCRIPTION OF DRAWING(S) - DESCRIPTION OF DRAWING - The drawing shows a block diagram depicting configuration of a control parameter calculator.

Behavior feature value detector 52

Behavior feature value memory 55

Behavior feature value calculator 56

Basic state judgment data calculator 57

Control parameter setter 62

ABSTRACTED-PUB-NO: US20040193337A
EQUIVALENT-ABSTRACTS:

CHOSEN-DRAWING: Dwg.4/11

DERWENT-CLASS: Q24 T01 W06
EPI-CODES: T01-J07D1; W06-C01A5;

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